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E21B 23/00

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(54) Abstract Title
Wellbore positioning system

(57) A wellbore positioning system for enabling the easy positioning of downhole tools comprises a series of spiral guide slots (5) which are formed on the inner surface of casing tubulars (1). A locating tool (7) is run into the wellbore attached to the downhole tool to be positioned such as a whipstock (10). The locating tool carries a spring loaded key (15) on its outer surface which is forced outwards by the spring and engages with the guide slot when they meet. The locating tool subsequently travels down into the wellbore following a spiral path until the key reaches the end of the guide slot. The downhole tool is now is the desired position. Several such guide slots may be located at different depths and rotational positions in the casing string. These different guide slots may have differing widths or profiles so as only to allow the engagement of predetermined keys thereby allowing the desired depth and rotational orientation of the tool to be accurately achieved.

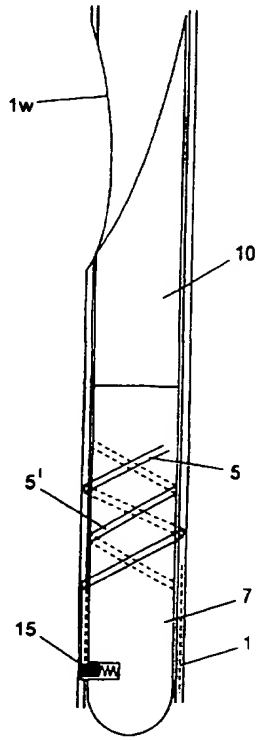

Fig. 4

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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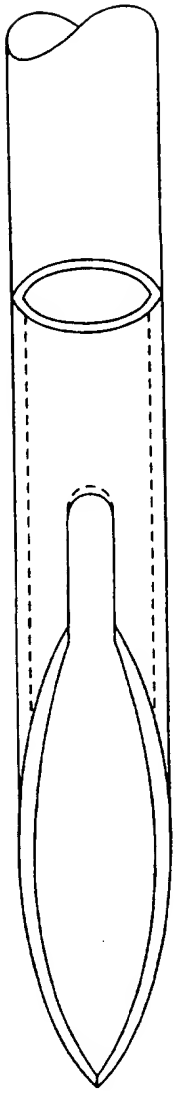

Fig. 1

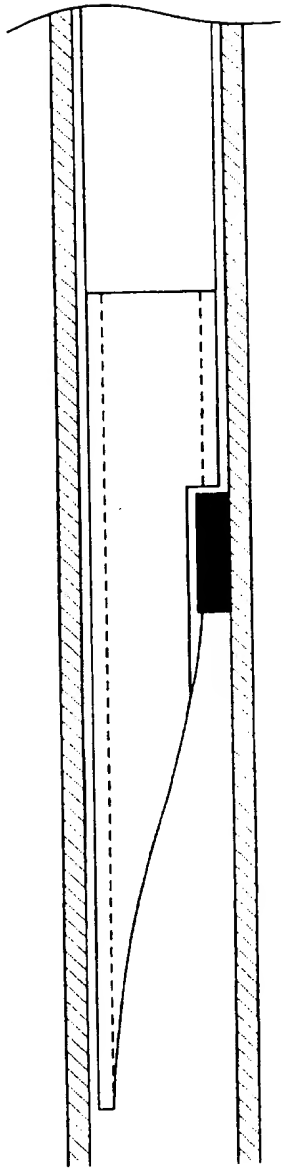

Fig. 1a

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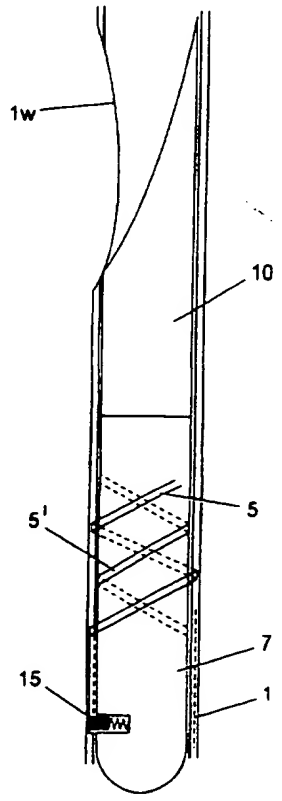

Fig. 4

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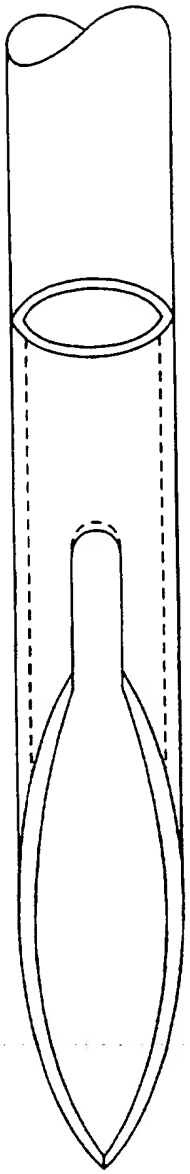

Fig. 1

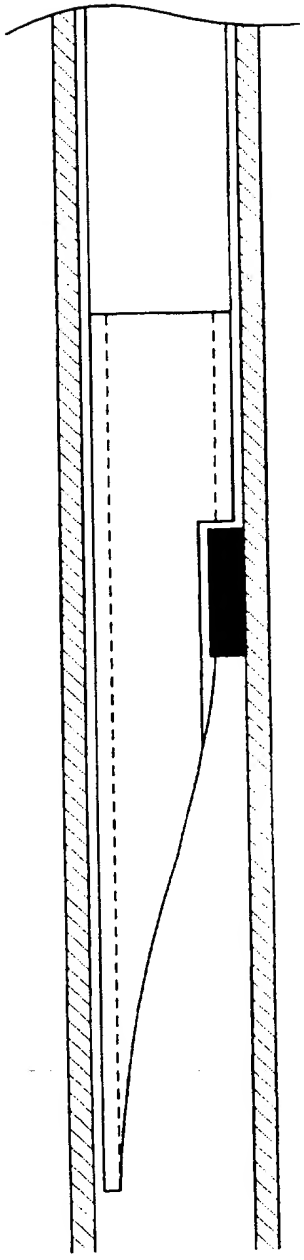

Fig. 1a

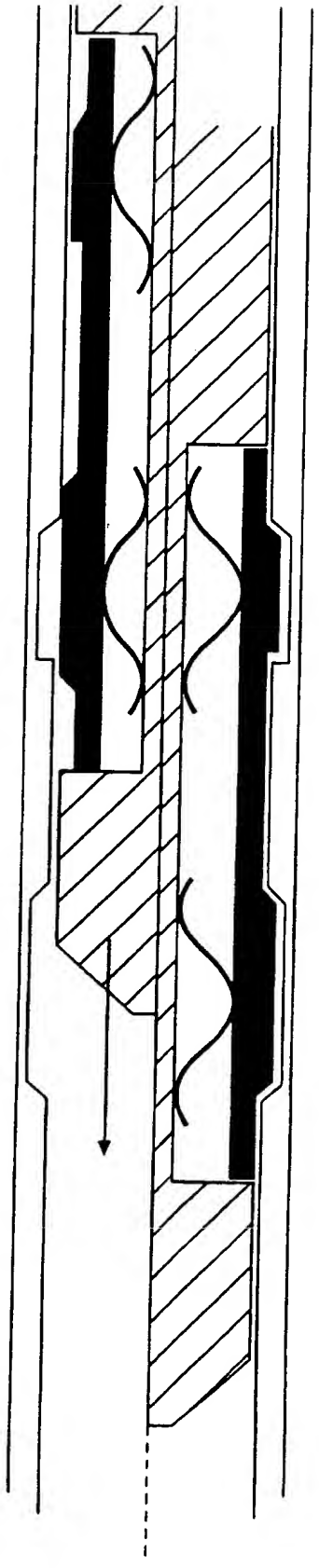

Fig. 2

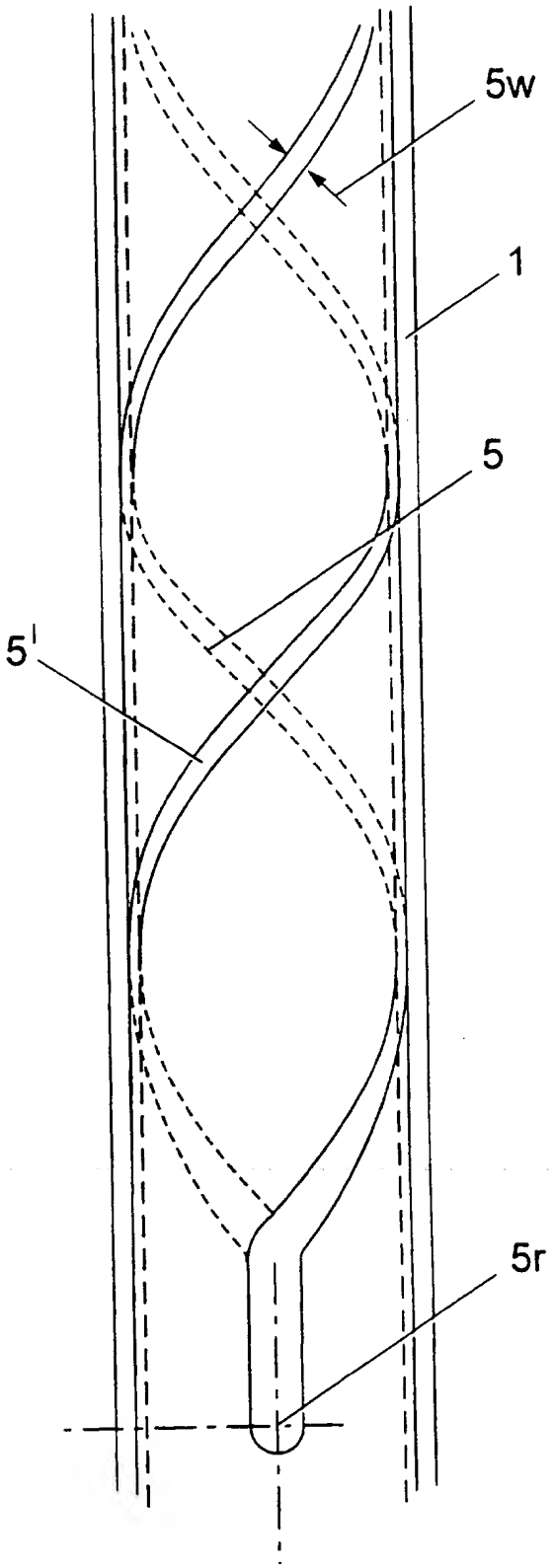

Fig. 3

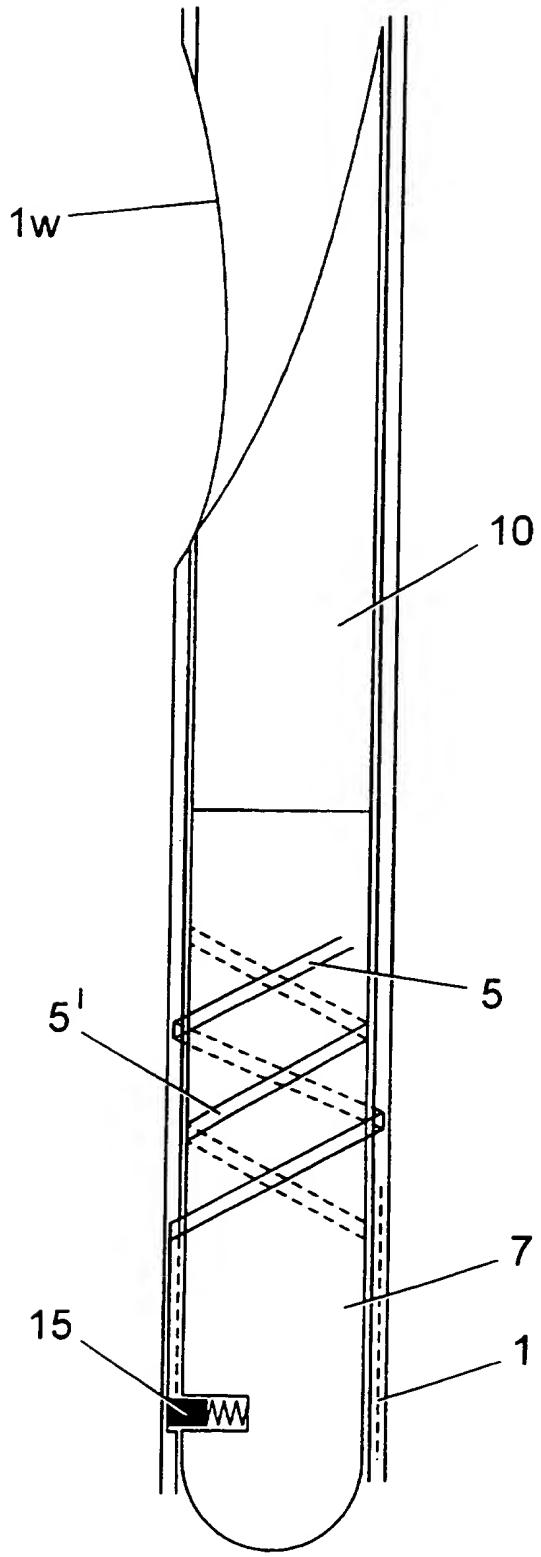

Fig. 4

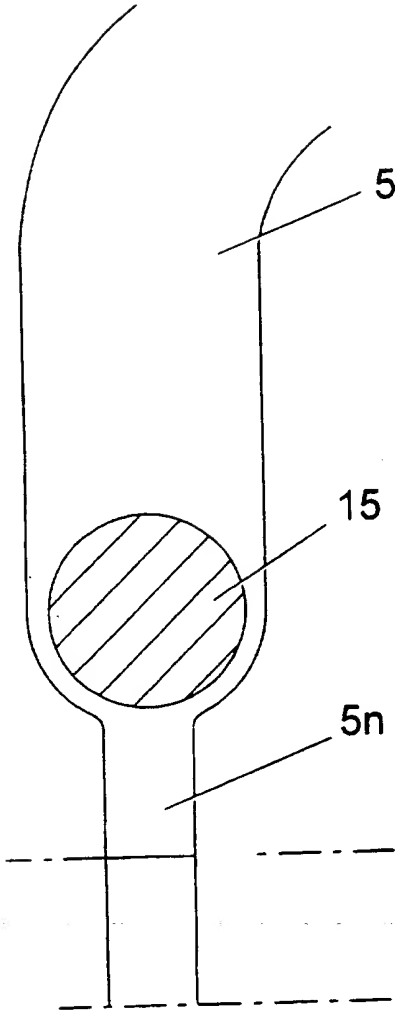

Fig. 5

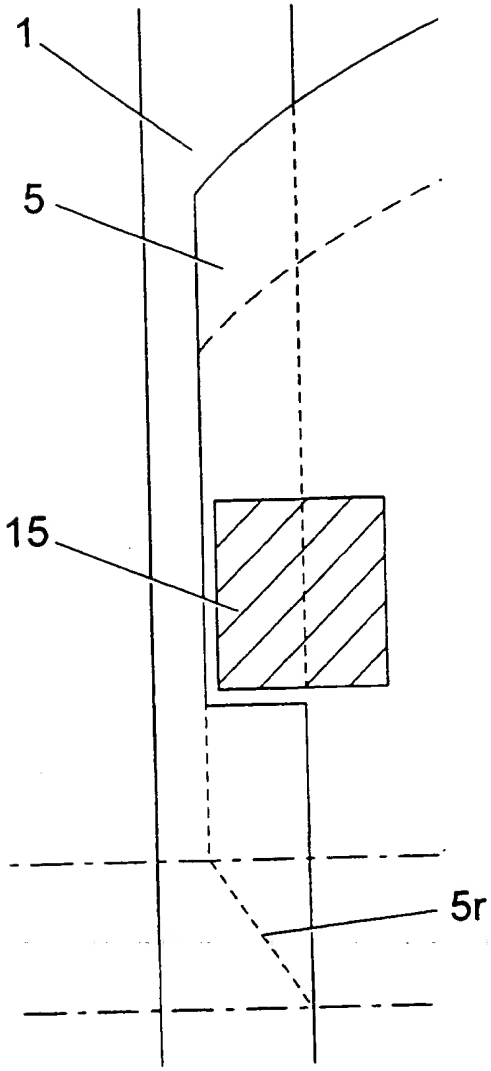

Fig. 5a

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"Wellbore Positioning System"

This invention relates to a wellbore positioning system for locating a downhole tool in a borehole.

A common problem faced when drilling oil wells is how to locate a downhole tool such as a whipstock inside a casing section repeatedly at the same depth and at the same orientation, for example in order to drill a deviated side track through a window in the casing. Several solutions to this problem have been found. The most basic is a muleshoe and key (see Fig. 1) where the key is set inside the casing in a fixed point and a muleshoe profile is machined into the tool being run, or into a separate muleshoe attachment fitted to the string. The muleshoe profile can alternatively be machined into the inner face of the casing (eg upside down with the apex pointing upwards), and a spring loaded key can be provided on the locating tool. In each case, the key comes to rest at a key seat machined into the wall of the muleshoe.

While the muleshoe allows rotational orientation and depth control of the whipstock or other downhole tool on the string, it does not allow multiple vertical

locations to be located automatically. In addition, the key can become snagged on the apex of the muleshoe rather than on the key seat. Also, if the muleshoe is machined into the inner face of the casing, which is preferred, there is a loss of effective diameter, and a consequent weakening in the casing. Furthermore, the key seat can become filled with accumulated debris which can prevent proper seating of the key.

In an effort to address the problem of identifying multiple vertical locations, location systems such as the selective key setting tool have been devised. In this tool (shown in Fig. 2), a number of locating profiles are machined into the casing, each having a unique shape, and a locating tool with laterally extending spring-loaded keys is run through the casing until the keys match with the desired locating profile, at which point the keys engage the profile and further downward movement is resisted. While this allows the identification of a particular vertical location corresponding to the key, it does not orient the locating tool or whipstock rotationally.

According to the present invention there is provided a wellbore system for selectively locating a downhole tool in a wellbore casing or tubing comprising a plurality of positioning guides spaced in the wellbore casing or tubing at predetermined depths wherein each positioning guide has a unique profile for selectively receiving a matching profile key of a downhole tool, the guides for each key having a configuration which controls the depth and rotational position of its matching key.

The control of the vertical and rotational position of the key thereby controls the vertical and rotational

position of the member.

The member can be a downhole assembly such as a running tool or a whipstock etc.

The invention also provides a method of selectively locating a downhole tool in a wellbore casing or tubing comprising the steps of:

a) placing a plurality of positioning guides at desired depths in the wellbore casing or tubing wherein each guide has a unique profile for selectively receiving a matching profile locating key,
b) selecting the profile of a locating key for the downhole tool to match the profile of a desired positioning guide, and
c) running the downhole tool to the desired positioning guide wherein the locating key engages the matching profile of the positioning guide which controls the depth and rotational position of the locating key to orient the downhole tool in a desired direction.

Preferably each key guide is a slot or a ledge, which in particular embodiments extend downwards and laterally. In a preferred embodiment the key guides are spiral slots, optionally covering a minimum of 450° of circumference.

By casing, we mean any downhole tubular such as casing, liner, drill pipe, or any functional equivalents.

It is an important aspect of the invention that each key guide only allows engagement of a particular key, such that the profile of the key only fits within the

profile or width of the key guide such as the slot. In particular cases, there can be more than two key guides, and/or more than two keys, so that multiple outlets spaced vertically and rotationally from one another in the casing string can be identified and particular tools in the work string can be located at different rotational positions and at different depths throughout the string.

In one embodiment, the keys can be spring loaded and/or retractable.

An embodiment of the present invention will now be described by way of example, and with reference to the accompanying drawings, in which:-

Fig. 1 shows a muleshoe arrangement of the prior art;
Fig. 2 shows a selective key locating system of the prior art;
Fig. 3 shows a casing tubular embodying a spiral groove in accordance with one aspect of the invention;
Fig. 4 shows a system of the invention being used to instal a whipstock to deflect a drill string through a window in a casing tubular; and
Fig. 5 shows the lower part of a groove in the Fig. 4 system.

Referring now to Figs. 3, 4 and 5, a system in accordance with one embodiment of the invention comprises a casing tubular 1 having spiral grooves 5 and 5' machined into its inner face. The grooves 5 and 5' are spaced around the inner circumference of the tubular 1 so that they start at opposite sides at 180° spacing. The spiral grooves 5 and 5' extend in a

counter-clockwise direction in order to prevent the inadvertent backoff of threaded connections above during the impact of the key of the locating tool against the groove, and each has a predetermined width 5w and profile. In the system of the invention shown in Figs. 3, 4 and 5, a locating tool 7 is mounted on a whipstock 10 at the lower end of a work string (not shown). A spring located key 15 is carried on the locating tool 7, and comprises a laterally extending boss of a predetermined size to fit within the width 5w of the spiral groove 5. The spring loaded key 15 is received within a recess in the locating tool and is sprung laterally so that it abuts against the inner face of the casing 1 in normal operation of the tool.

In use, the whipstock 10 and locating tool 7 are inserted into a casing string by a conventional work string etc (not shown) until the boss on the spring loaded key 15 engages the slot 5 in the casing 1. When the boss is located in the spiral slot, the movement of the whipstock 10 and locating tool 7 is restricted to a downward spiral movement until the boss engages at the rest location 5r at the end of the slot 5. The whipstock is oriented in relation to the locating tool such that when the boss on the key 15 is at the rest location 5r in the slot 5, the whipstock 10 is positioned to deflect a drill string (not shown) from above through a window 1w in the casing 1.

Modifications and improvements can be incorporated without departing from the scope of the invention. For instance, three or more spiral grooves can be provided in the casing string at different rotational and/or vertical locations (ie at different depths). Different spiral slots can have differing widths or profiles so as to allow the engagement of only predetermined keys

15. By selecting the appropriate key on the locating tool, the rotational and/or vertical positioning of the locating tool (and hence the whipstock, or other downhole tool) can be determined from the surface simply by inserting the locating tool 7 and whipstock 10 into the casing string and delivering the assembly to the appropriate depth until the key 15 engages in the slot.

Where separate slots are spaced vertically from one another, any one slot will preferably be of narrower width or profile than the slot immediately below it, so that the slot first engaged by the key on the locating tool being inserted will only be engaged if the profiles of the key and slot fit, and larger keys intended for positioning further down the casing string will not engage with narrower slots at the upper levels of the casing string.

In certain embodiments (an example is shown in Fig. 5) the groove 5 has a profile at the key seat to facilitate self-cleaning of the groove 5. In the example shown in Fig. 5, these comprise a narrower portion of the groove 5n through which the key 15 cannot pass and/or a ramped profile 5r to prevent accumulation of debris at the key seat.

It is of course possible to have different profiles or widths of slot at the same vertical position, but at different rotational positions, so that by engaging the appropriate key into the slot, the rotational resting position of the locating tool can be specified even if the depth is not altered.

CLAIMS

1. A wellbore system for selectively locating a downhole tool in a wellbore casing or tubing comprising a plurality of positioning guides spaced in the wellbore casing or tubing at predetermined depths wherein each positioning guide has a unique profile for selectively receiving a matching profile key of a downhole tool, the guide for each key having a configuration which controls the depth and rotational position of its matching key.

2. The wellbore system according to Claim 1, wherein the positioning guides are slots or ledges which extends downwardly and laterally.

3. The wellbore system according to any preceding claim, wherein each positioning guide is spiral-shaped.

4. A wellbore system according to any preceding claim, wherein each positioning guide spirals around a minimum of 450° of circumference.

5. A wellbore system according to any preceding claim, wherein the keys are spring loaded, extendable and/or retractable.

6. A wellbore system according to any preceding claim, wherein each positioning guide is a slot with a unique width for selectively receiving a matching key of substantially the same width.

7. A wellbore system according to any preceding claim, wherein the downhole tool is a whipstock.

8. A wellbore system according to any preceding

claim, wherein the downhole tool is a running tool.

9. A method of selectively locating a downhole tool in a wellbore casing or tubing comprising the steps of:

a) placing a plurality of positioning guides at desired depths in the wellbore casing or tubing wherein each guide has a unique profile for selectively receiving a matching profile locating key,

b) selecting the profile of a locating key for the downhole tool to match the profile of a desired positioning guide, and

c) running the downhole tool to the desired positioning guide wherein the locating key engages the matching profile of the positioning guide which controls the depth and rotational position of the locating key to orient the downhole tool in a desired direction.

10. The method of Claim 9, wherein the positioning guides are slots or ledges which extend downwardly and laterally.

11. The method according to Claims 9 or 10, wherein each positioning guide is spiral-shaped.

12. The method according to any one of Claims 9 to 11, wherein each positioning guide spirals around a minimum of about 450° of circumference.

13. The method of any one of Claims 9 to 12, wherein the locating key is spring loaded and/or retractable.

14. The method according to any of Claims 9 to 13, wherein the downhole tool is a whipstock.

15. The method according to any one of Claims 9 to 13, wherein the downhole tool is a running tool.

16. The method according to any one of Claims 9 to 13, wherein a second downhole tool with a different profiled locating key is located in a second positioning guide above the first positioning guide.

17. The method according to any one of Claims 9 to 16, wherein each positioning guide is a slot with a unique width for selectively receiving a matching key of substantially the same width.

18. A wellbore system as hereinbefore described with reference to any one of Figs. 3 to 5 of the accompanying drawings.

19. A method of selectively locating a downhole tool in a wellbore casing or tubing as hereinbefore described.

The Patent Office

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Application No: GB 9827734.6
Claims searched: 1-19

Examiner: J. C. Cowen
Date of search: 3 March 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): E1F FAU, FCU, FCX, FGU, FKB, FKC, FKG, FKU

Int Cl (Ed.6): E21B 23/00, 23/01

Other: WPI, EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2,138,867 (Ava International Coorporation)	1,5,13
A	GB 2,302,109 (Baroid Technology Inc)	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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